Biological Evaluation of Kentucky Department of Environmental Protection Water Quality Standards

For the U.S. Fish and Wildlife Service

Prepared by

U.S. Environmental Protection Agency
Region 4
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Chapter I. Federal Action

A. Overview

This Biological Evaluation (BE) was prepared to determine, under § 7(a)(2) of the Endangered Species Act (ESA), whether effects may occur to threatened and endangered species and/or designated critical habitat (CH) from the .U.S. Environmental Protection Agency's potential approval of revised and new aquatic life water quality standards as related to the protection of fish & aquatic life uses and criteria for the protection of these uses as adopted by the Kentucky Department of Environmental Protection (KDEP or the State). The BE provides the EPA's analysis of the potential effects on threatened and endangered species and designated critical habitat by the EPA's potential approval of the State's water quality standards as related to aquatic life uses and criteria. The changes to the State's rule language specific to fish and aquatic life protection include updates consistent with the EPA's recently published recommended WQS criteria for one parameter (Cadmium) and the adoption of the EPA's recommended WQS criteria for one parameter (Carbaryl).

B. Clean Water Act and applicable regulations

Section 303 of the Clean Water Act (CWA), 33 United States Code §1313, requires states and authorized tribes to establish Water Quality Standards (WQS) and to submit any new or revised standards to the EPA for review and approval or disapproval. State's WQS are not effective for CWA purposes until approved by the EPA [40 CFR § 131.21(c)].

In addition to the EPA's review under §303(c) of the CWA, §7(a)(2) of the ESA requires federal agencies, in consultation with the Fish and Wildlife Service (FWS) and/or the National Marine Fisheries Service (NMFS), to ensure that their actions are not likely to jeopardize the continued existence of federally listed species or result in the destruction or adverse modification of designated critical habitat of such species. As provided in the 2001 Memorandum of Agreement between the EPA, the FWS, and the NMFS regarding enhanced coordination of CWA and ESA obligations, the EPA uses a BE to analyze whether a new or revised water quality standard may affect federally listed species or designated critical habitat. If the EPA determines that approval may affect listed species or critical habitat but is not likely to adversely affect listed species or habitat, then formal consultation with the FWS is not required if the FWS concurs on the "may affect, not likely to adversely affect" finding.

C. Timeline of the specific federal action

KDEP held a public hearing on July 23, 2019 regarding these revised water quality regulations. The revisions were considered by the legislative Administrative Regulation Review Subcommittee on November 12, 2019 and subsequently referred to the Natural Resources and Energy Committee on December 4, 2019. The committee did not meet to consider these regulations within 30 days and therefore, all five regulations became effective January 5, 2020. KDEP submitted new and revised water quality standards to the EPA by letter dated February 26, 2020, which was received by the EPA on March 3, 2020. KDEP's submittal included a certification letter dated February 24, 2020, signed by Elizabeth Natter, General Counsel for the Kentucky Energy and Environment Cabinet, which stated that the revisions were duly adopted in accordance with State law.

D. Summary of the State's new/revised fish and aquatic life WQS

Parameter		Change Made	Revision Redline	
			CMC µg/L	CCC µg/L
			µg/L unless other units are indicated	
1.	Cadmium	Updated existing criteria to match the EPA's 2016 Aquatic Life Ambient Water Quality Recommendations for Dissolved Cadmium	e^(0.9789(ln Hardness)-3.866) ~~e^(1.0166(ln Hardness)-3.924)~~	e^(0.7977(ln Hardness)-3.909) ~~e^(0.7409(ln Hardness)-4.719)~~
2.	Carbaryl	Adopted the EPA's April 2012 Aquatic Life Ambient Water Quality Criteria Recommendations for Carabaryl	2.1	2.1

NOTE: KDEP's WQS: Rule 401 KAR 10:031 Surface Water Standards complete redline version is in Appendix A.

Chapter II. Action Area

The action includes all the waters of the United States within the jurisdiction of the Commonwealth of Kentucky.

Waters of the United States means: (a) All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to ebb and flow of the tide; (b) All interstate waters, including interstate "wetlands;" (c) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, "wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters: (1) Which are or could be used by interstate or foreign travelers for recreational or other purposes; (2) From which fish or shellfish could be taken and sold in interstate or foreign commerce; (3) Which are used or could be used for industrial purposes by industries in interstate commerce; (d) All impoundments of waters otherwise defined as waters of the United States under this definition; (e) Tributaries of waters identified in paragraphs (a) through (d) of this definition; (f) The territorial sea; and (g) "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition. [40 CFR § 122.2 *Waters of the United States* or *waters of the* U.S.]

Chapter III. Species and Critical Habitat

Table III. A.
Federally Listed Species by Category, Scientific Name, Common Name, Taxonomic Family, Listing Status and Critical Habitat found within the Commonwealth of Kentucky, April 2020

Category	Scientific Name	Common Name	Family	Listing Status[1]	Critical Habitat
Clam	*Cumberlandia monodonta*	Spectaclecase	Margaritiferidae	E	-
Clam	*Alasmidonta atropurpurea*	Cumberland elktoe	Unionidae	E	CH
Clam	*Cyprogenia stegaria*	fanshell	Unionidae	E	-
Clam	*Dromus dromas*	dromedary pearlymussel	Unionidae	E	-
Clam	*Epioblasma brevidens*	Cumberlandian combshell	Unionidae	E	CH
Clam	*Epioblasma capsaeformis*	oyster mussel	Unionidae	E	CH
Clam	*Epioblasma florentina florentina*	yellow blossom (pearlymussel)	Unionidae	E	-
Clam	*Epioblasma obliquata obliquata*	catspaw (=purple cat's paw pearlymussel)	Unionidae	E	-
Clam	*Epioblasma torulosa rangiana*	northern riffleshell	Unionidae	E	-
Clam	*Epioblasma triquetra*	snuffbox mussel	Unionidae	E	-
Clam	*Lampsilis abrupta*	pink mucket (pearlymussel)	Unionidae	E	-
Clam	*Obovaria retusa*	ring pink (mussel)	Unionidae	E	-
Clam	*Pegias fabula*	littlewing pearlymussel	Unionidae	E	-
Clam	*Plethobasus cooperianus*	orangefoot pimpleback (pearlymussel)	Unionidae	E	-
Clam	*Plethobasus cyphyus*	sheepnose mussel	Unionidae	E	-
Clam	*Pleurobema clava*	clubshell	Unionidae	E	-
Clam	*Pleurobema plenum*	rough pigtoe	Unionidae	E	-
Clam	*Potamilus capax*	fat pocketbook	Unionidae	E	-
Clam	*Ptychobranchus subtentum*	fluted kidneyshell	Unionidae	E	CH
Clam	*Quadrula cylindrica cylindrica*	rabbitsfoot	Unionidae	T	CH
Clam	*Villosa trabalis*	Cumberland bean (pearlymussel)	Unionidae	E	-
Crayfish	*Cambarus callainus*	Big Sandy crawfish	Cambaridae	T	-
Cave Shrimp	*Palaemonias gunteri*	Kentucky cave shrimp	Atyidae	E	CH
Fish	*Scaphirhynchus albus*	pallid sturgeon	Acipenseridae	E	-
Fish	*Notropis albizonatus*	palezone shiner	Cyprinidae	E	-
Fish	*Phoxinus cumberlandensis*	blackside dace	Cyprinidae	T	-
Fish	*Etheostoma chienense*	Relict darter	Percidae	E	-
Fish	*Etheostoma percnurum*	duskytail darter	Percidae	E	-
Fish	*Etheostoma spilotum*	Kentucky arrow darter	Percidae	T	CH

[1] E = Endangered, T = Threatened, PE = Proposed Endangered, CH = Critical Habitat designated

Table III. A.
Federally Listed Species by Category, Scientific Name, Common Name, Taxonomic Family, Listing Status and Critical Habitat found within the Commonwealth of Kentucky, April 2020

Category	Scientific Name	Common Name	Family	Listing Status[1]	Critical Habitat
Fish	*Etheostoma susanae*	Cumberland darter	Percidae	E	CH
Bat	*Corynorhinus (=Plecotus) townnsendii virginianus*	Virginia big-eared bat	Vespertilionidae	E	-
Bat	*Myotis grisescens*	gray bat	Vespertilionidae	E	-
Bat	*Myotis septentrionalis*	Northern long-eared bat	Vespertilionidae	T	-
Bat	*Myotis sodalis*	Indiana bat	Vespertilionidae	E	CH
Bird	*Sterna antillarum*	least tern	Laridae	E	-

Table III. B.

Kentucky Critical Habitat Listed by Water Body, County, Common Name, & Scientific Name

WATER BODY	COUNTY	COMMON NAME	SCIENTIFIC NAME
Bunches Creek	Whitley	Cumberland Darter	*Etheostoma susanae*
Calf Pen Fork	Whitley	Cumberland Darter	*Etheostoma susanae*
Youngs Creek	Whitley	Cumberland Darter	*Etheostoma usanae*
Barren Fork	McCreary	Cumberland Darter	*Etheostoma usanae*
Indian Creek	McCreary	Cumberland Darter	*Etheostoma susanae*
Cogur Fork	McCreary	Cumberland Darter	*Etheostoma susanae*
Kilburn Fork	McCreary	Cumberland Darter	*Etheostoma susanae*
Laurel Fork	McCreary	Cumberland Darter	*Etheostoma susanae*
Laurel Creek	McCreary	Cumberland Darter	*Etheostoma susanae*
Elisha Branch	McCreary	Cumberland Darter	*Etheostoma susanae*
Jenneys Branch	McCreary	Cumberland Darter	*Etheostoma susanae*
Wolf Creek	Whitley	Cumberland Darter	*Etheostoma susanae*
Jellico Creek	McCreary	Cumberland Darter	*Etheostoma susanae*
Rock Creek	McCreary	Cumberland Darter	*Etheostoma susanae*
Capuchin Creek	Whitley	Cumberland Darter	*Etheostoma susanae*
Rock Creek	McCreary	Cumberland Elktoe	*Alasmidonta atropurpurea*
Big South Fork-Cumberland River	McCreary	Cumberland Elktoe	*Alasmidonta atropurpurea*
Marsh Creek	McCreary	Cumberland Elktoe	*Alasmidonta atropurpurea*
Laurel Fork	Whitley	Cumberland Elktoe	*Alasmidonta atropurpurea*
Big South Fork-Cumberland River	McCreary	Cumberlandian Combshell	*Epioblasma brevidens*
Buck Creek	Pulaski	Cumberlandian Combshell	*Epioblasma brevidens*
Green River	Edmonson	Diamond Darter	*Crystallaria cincotta*
Green River	Hart	Diamond Darter	*Crystallaria cincotta*
Green River	Green	Diamond Darter	*Crystallaria cincotta*
Horse Lick Creek	Rockcastle	Fluted Kidneyshell	*Ptychobranchus subtentum*
Horse Lick Creek	Jackson	Fluted Kidneyshell	*Ptychobranchus subtentum*
Middle Fork Rockcastle River	Jackson	Fluted Kidneyshell	*Ptychobranchus subtentum*
Rockcastle River	Pulaski	Fluted Kidneyshell	*Ptychobranchus subtentum*
Rockcastle River	Laurel	Fluted Kidneyshell	*Ptychobranchus subtentum*
Rockcastle River	Rockcastle	Fluted Kidneyshell	*Ptychobranchus subtentum*
Buck Creek	Pulaski	Fluted Kidneyshell	*Ptychobranchus subtentum*
Rock Creek	McCreary	Fluted Kidneyshell	*Ptychobranchus subtentum*
Little South Fork Cumberland River	McCreary	Fluted Kidneyshell	*Ptychobranchus subtentum*
Little South Fork Cumberland River	Wayne	Fluted Kidneyshell	*Ptychobranchus subtentum*
Big South Fork Cumberland River	McCreary	Fluted Kidneyshell	*Ptychobranchus subtentum*
Buckhorn Creek	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Prince Fork	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Eli Fork	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Snag Ridge Fork	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*

Table III. B.

Kentucky Critical Habitat Listed by Water Body, County, Common Name, & Scientific Name

WATER BODY	COUNTY	COMMON NAME	SCIENTIFIC NAME
Coles Fork	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Coles Fork	Breathitt	Kentucky Arrow Darter	*Etheostoma spilotum*
Clemons Fork	Breathitt	Kentucky Arrow Darter	*Etheostoma spilotum*
Fitch Branch	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Newman Branch	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Combs Branch	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Laurel Fork Quicksand Creek	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Big Firecoal Branch	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Bradley Branch	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Lynn Log Branch	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Middle Fork Quicksand Creek	Knott	Kentucky Arrow Darter	*Etheostoma spilotum*
Spring Fork Quicksand Creek	Breathitt	Kentucky Arrow Darter	*Etheostoma spilotum*
Hunting Creek and Tributaries	Breathitt	Kentucky Arrow Darter	*Etheostoma spilotum*
Frozen Creek and Tributaries	Breathitt	Kentucky Arrow Darter	*Etheostoma spilotum*
Holly Creek and Tributaries	Wolfe	Kentucky Arrow Darter	*Etheostoma spilotum*
Little Fork	Lee	Kentucky Arrow Darter	*Etheostoma spilotum*
Little Fork	Wolfe	Kentucky Arrow Darter	*Etheostoma spilotum*
Walker Creek and Tributaries	Lee	Kentucky Arrow Darter	*Etheostoma spilotum*
Walker Creek and Tributaries	Wolfe	Kentucky Arrow Darter	*Etheostoma spilotum*
Hell Creek and Tributaries	Lee	Kentucky Arrow Darter	*Etheostoma spilotum*
Big Laurel Creek	Harlan	Kentucky Arrow Darter	*Etheostoma spilotum*
Laurel Creek	Leslie	Kentucky Arrow Darter	*Etheostoma spilotum*
Hell for Certain Creek and Tribs	Leslie	Kentucky Arrow Darter	*Etheostoma spilotum*
Squabble Creek	Perry	Kentucky Arrow Darter	*Etheostoma spilotum*
Blue Hole Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Left Fork Blue Hole Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Upper Bear Creek and Tribs	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Katies Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Spring Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Little Spring Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Bowen Creek and Tributaries	Leslie	Kentucky Arrow Darter	*Etheostoma spilotum*
Elisha Creek and Tributaries	Leslie	Kentucky Arrow Darter	*Etheostoma spilotum*
Gilberts Big Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Gilberts Big Creek	Leslie	Kentucky Arrow Darter	*Etheostoma spilotum*
Sugar Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Sugar Creek	Leslie	Kentucky Arrow Darter	*Etheostoma spilotum*
Big Double Creek and Tributaries	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Little Double Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Jacks Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Long Fork	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Horse Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*
Bullskin Creek	Clay	Kentucky Arrow Darter	*Etheostoma spilotum*

Table III. B.

Kentucky Critical Habitat Listed by Water Body, County, Common Name, & Scientific Name

WATER BODY	COUNTY	COMMON NAME	SCIENTIFIC NAME
Bullskin Creek	Leslie	Kentucky Arrow Darter	*Etheostoma spilotum*
Buffalo Creek and Tributaries	Owsley	Kentucky Arrow Darter	*Etheostoma spilotum*
Lower Buffalo Creek	Owsley	Kentucky Arrow Darter	*Etheostoma spilotum*
Lower Buffalo Creek	Lee	Kentucky Arrow Darter	*Etheostoma spilotum*
Silver Creek	Lee	Kentucky Arrow Darter	*Etheostoma spilotum*
Travis Creek	Jackson	Kentucky Arrow Darter	*Etheostoma spilotum*
Wild Dog Creek	Jackson	Kentucky Arrow Darter	*Etheostoma spilotum*
Wild Dog Creek	Owsley	Kentucky Arrow Darter	*Etheostoma spilotum*
Granny Dismal Creek	Owsley	Kentucky Arrow Darter	*Etheostoma spilotum*
Granny Dismal Creek	Lee	Kentucky Arrow Darter	*Etheostoma spilotum*
Rockbridge Fork	Wolfe	Kentucky Arrow Darter	*Etheostoma spilotum*
Roaring River passage	Edmonson	Kentucky Cave Shrimp	*Palaemonias ganteri*
Big South Fork Cumberland River	McCreary	Oyster Mussel	*Epioblasma capsaeformis*
Buck Creek	Pulaski	Oyster Mussel	*Epioblasma capsaeformis*
Tennessee River	Livingston	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Tennessee River	Marshall	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Tennessee River	McCracken	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Ohio River	Ballard	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Ohio River	McCracken	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Green River	Edmonson	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Green River	Hart	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Green River	Taylor	Rabbitsfoot	*Quadrula cylindrica cylindrica*

Table III. C.
List of Federally Listed Species by Scientific Name, Group, Phylum, Class, Order and Family

Scientific Name	Group	Phylum	Class	Order	Family
Alasmidonta atropurpurea	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Cumberlandia monodonta	Clams	Mollusca	Bivalvia	Unionoida	Margaritiferidae
Cyprogenia stegaria	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Dromus dromas	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Epioblasma brevidens	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Epioblasma capsaeformis	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Epioblasma florentina florentina	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Epioblasma obliquata obliquata	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Epioblasma torulosa rangiana	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Epioblasma triquetra	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Lampsilis abrupta	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Obovaria retusa	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Pegias fabula	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Plethobasus cooperianus	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Plethobasus cyphyus	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Pleurobema clava	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Pleurobema plenum	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Potamilus capax	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Ptychobranchus subtentum	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Quadrula cylindrica cylindrica	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Villosa trabalis	Clams	Mollusca	Bivalvia	Unionoida	Unionidae
Cambarus callainus	Crustaceans	Crustacea	Malacostraca	Decapoda	Cambaridae
Palaemonias gunteri	Crustaceans	Crustacea	Malacostraca	Decapoda	Atyidae
Etheostoma chienense	Fishes	Craniata	Actinopterygii	Perciformes	Percidae
Etheostoma percnurum	Fishes	Craniata	Actinopterygii	Perciformes	Percidae
Etheostoma spilotum	Fishes	Craniata	Actinopterygii	Perciformes	Percidae
Etheostoma susanae	Fishes	Craniata	Actinopterygii	Perciformes	Percidae
Notropis albizonatus	Fishes	Craniata	Actinopterygii	Cypriniformes	Cyprinidae
Phoxinus cumberlandensis	Fishes	Craniata	Actinopterygii	Cypriniformes	Cyprinidae
Scaphirhynchus albus	Fishes	Craniata	Actinopterygii	Acipenseriformes	Acipenseridae
Corynorhinus (=Plecotus) townnsendii virginianus	Mammals	Craniata	Mammalia	Chiroptera	Vespertilionidae
Myotis grisescens	Mammals	Craniata	Mammalia	Chiroptera	Vespertilionidae
Myotis septentrionalis	Mammals	Craniata	Mammalia	Chiroptera	Vespertilionidae
Myotis sodalis	Mammals	Craniata	Mammalia	Chiroptera	Vespertilionidae
Sterna antillarum	Birds	Chordata	Aves	Charadriiformes	Laridae

Manner in which EPA's Approval of Cadmium CMC & CCC may affect the Federally Listed Species and their critical habitat

A. 1. Adopted values of Cadmium-

Kentucky revised the following values resulting from the equation expressed below:

Parameter	Revision Redline	
	CMC µg/L (Acute)	CCC µg/L (Chronic)
Cadmium	e^(0.9789(ln Hardness)-3.866) ~~e^(1.0166(ln Hardness)-3.924)~~	e^(0.7977(ln Hardness)-3.909) ~~e^(0.7409(ln Hardness)-4.719)~~

Summary of EPA's 2001 and 2016 Aquatic Life Recommendations for Dissolved Cadmium				
	2016 AWQC Update[a]		2001 AWQC[a]	
	Acute (1-hour, dissolved Cd)[d]	**Chronic (4-day, dissolved Cd)**	**Acute (1-day, dissolved Cd)**	**Chronic (4-day, dissolved Cd)**
Freshwater (Total Hardness = 100 mg/L as CaCO3)[b]	1.8 µg/L[c]	0.72 µg/L	2.0 µg/L[c]	0.25 µg/L

[a] Values are recommended not to be exceeded more than once every three years on average.
[b] Freshwater acute and chronic criteria are hardness-dependent and were normalized to a hardness of 100 mg/L as CaCO3 to allow the presentation of representative criteria values.
[c] Lowered to protect the commercially and recreationally important species (rainbow trout), as per the 1985 Guidelines, Stephan et al. (1985).
[d] The duration of the 2016 acute criteria was changed to 1-hour to reflect the 1985 Guidelines-based recommended acute duration.

A. 2.a. Cadmium Acute (CMC) values by category: Clams/Mussels, Crustaceans/Crayfish, Fish, Bats and Birds

CLAMS/MUSSELS

Cadmium Mussel data from Table 7 (Pages 37 - 42) of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs.			
Rank	GMAV (*ug*/L total)	Type, Scientific name	SMAV (*ug*/L total)
16	71.76	Mussel, *Utterbackia imbecillis*	71.76
15	70.76	Southern rainbow mussel, *Villosa vibex*	70.76

14	68.51	Mussel, *Lasmigona subviridis*	68.51
13	67.9	Mussel, *Actinonaias pectorosa*	67.9
10	51.34	Neosho mucket, *Lampsilis rafinesqueana (LS)*	44.67
		Fatmucket, *Lampsilis siliquoidea*	35.73
		Southern fatmucket, *Lampsilis straminea claibornensis*	93.17
		Yellow sandshell, *Lampsilis teres*	46.71

These eight Unionidae mussels are considered surrogates for the 21 Federally listed mussel species found in Table III.A, and each was tested acutely for Cadmium. The most sensitive species SMAV (fatmucket, *Lampsilis siliquoidea*) is 20 times higher than the 1.8 ug/L CMC at the 1-hour duration for dissolved Cadmium at 100 mg/L hardness. The most sensitive GMAV (*Lampsilis*) is over 28 times higher than the CMC Cadmium value.

The fish which are the hosts for the Unionidae mussels will be protected by the proposed Cadmium CMC criteria and that discussion is included below on the fish species.
Based on this information, the use of the Cadmium acute criteria as proposed by the Commonwealth of Kentucky will have **NO EFFECT** on the 20 federally listed Unionid mussels and the *Cumberlandia monodonta* and **NO ADVERSE MODICATION** to their critical habitat.

CRUSTACEANS/CRAYFISH

Cadmium Crayfish data from Table 7 (Pages 37 - 42) of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs.			
Rank	GMAV (*ug*/L total)	Type, Scientific name	SMAV (*ug*/L total)
22	94.67	Crayfish, *Faxonius immunis*	>22,579b
		Crayfish, *Faxonius juvenilis*	134
		Crayfish, *Faxonius placidus*	66.89
		Crayfish, *Faxonius virilis*	22,800b

The four crayfish tested for acute Cadmium toxicity are considered surrogates for the Big Sandy Cray Fish and the Kentucky Cave Shrimp because they all belonged to the same Family and Order, respectively. The most sensitive cray fish species SMAV is over 37 times higher than the 1.8 *ug*/L CMC at the 1-hour duration for total Cadmium at 100 mg/L hardness. The most sensitive GMAV is more than 52 times higher than the CMC at the 1-hour duration for total Cadmium at 100 mg/L hardness.

Therefore, the use of the Cadmium acute criteria proposed by the Commonwealth of Kentucky will result in **NO EFFECT** on the federally listed Big Sandy Cray Fish and Kentucky Cave Shrimp.

FISHES

Cadmium Fish data from Table 7 (Pages 37 - 42) of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs.			
Rank	GMAV (*ug*/L total)	Type, Scientific name	SMAV (*ug*/L total)
74	30,781	Common carp, *Cyprinus carpio*	30,781
73	26,837	Nile tilapia, *Oreochromis niloticus*	66,720

Cadmium Fish data from Table 7 (Pages 37 - 42) of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs.			
Rank	GMAV (*ug*/L total)	Type, Scientific name	SMAV (*ug*/L total)
		Mozambique tilapia, *Oreochromis mossambica*	10,795
69	12,100	Mosquitofish, *Gambusia affinis*	12,100
66	11,045	Threespine stickleback, *Gasterosteus aculeatus*	11,045
65	9,917	Channel catfish, *Ictalurus punctatus*	9,917
62	7,752	Green sunfish, *Lepomis cyanellus*	6,276
		Bluegill, *Lepomis macrochirus*	9,574
61	7,716	Red shiner, *Cyprinella lutrensis*	7,716
49	2,967	Zebrafish, *Danio rerio*	2,967
43	1,582	Fathead minnow, *Pimephales promelas*	1,582
20	80.38	Bonytail, *Gila elegans (LS)*	80.38
19	76.02	Razorback sucker, *Xyrauchen texanus (LS)*	76.02
9	46.79	Colorado pikeminnow, *Ptychocheilus lucius (LS)*	46.79
		Northern pikeminnow, *Ptychocheilus oregonensis*	4,265b
8	<33.78	White sturgeon, *Acipenser transmontanus (LS)*	<33.78
6	>15.72	Mountain whitefish, *Prosopium williamsoni*	>15.72
5	6.141	Cutthroat trout, *Oncorhynchus clarkii*	5.401
		Coho salmon, *Oncorhynchus kisutch (LS)*	11.88
		Rainbow trout, *Oncorhynchus mykiss (LS)*	3.727
-		Chinook salmon, *Oncorhynchus tshawytscha (LS)*	5.949
4	5.931	Striped bass, *Morone saxatilis*	5.931
3	5.642	Brown trout, *Salmo trutta*	5.642
2	4.411	Mottled sculpin, *Cottus bairdii*	4.418
-		Shorthead sculpin, *Cottus confusus*	4.404
1	4.19	Bull trout, *Salvelinus confluentus*	4.19

Pallid sturgeon

The Pallid sturgeon is an opportunist feeder eating aquatic insects, crustaceans, mollusks, annelids, eggs of other fishes, and sometimes other fishes. The data indicates the Cadmium CMC criteria will protect these food sources and will have no effect on the aquatic insect abundance or composition.

Cadmium Data from Table 7 (Pages 37 - 42) of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs.			
Rank	GMAV (*ug*/L total)	Type, Scientific name	SMAV (*ug*/L total)
7	23	Amphipod, *Hyalella azteca*	23
12	61.42	Cladoceran, *Daphnia ambigua*	24.81
		Cladoceran, *Daphnia magna*	40.62
		Cladoceran, *Daphnia pulex*	109.2
		Cladoceran, *Daphnia similis*	129.3
17	73.67	Cladoceran, *Ceriodaphnia dubia*	64.03
		Cladoceran, *Ceriodaphnia reticulata*	84.76
23	99.54	Isopod, *Lirceus alabamae*	99.54

Cadmium Data from Table 7 (Pages 37 - 42) of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs.			
Rank	GMAV (*ug*/L total)	Type, Scientific name	SMAV (*ug*/L total)
24	103.1	Cladoceran, *Diaphanosoma brachyurum*	103.1

As shown above, the most sensitive insect tested was an amphipod. It ranked seventh of the most sensitive 75 Genius. Its SMAV was 23 *ug*/L Ca or more than 12 times higher than the 1.8 *ug*/L Ca CMC at the 1-hour duration at 100 mg/L of hardness. The other insects that were tested include Cladoceran and Isopods. These SMAVs ranged from 24.8 *ug*/L to 103.1 *ug*/L Cd at a hardness of 100 mg/L $CaCO_3$. These SMAVs are 13 to 57 times higher than the 1.8 *ug*/L calculated as the CMC for a hardness of 100 mg/L $CaCO_3$. The Cadmium CMC criteria will have no effect on the crustaceans and mussels as described above in the Snail, Mussel and Crustecean topics above. The Cadmium CMC criteria will have no effect on the sturgeon's fish food item abundance or composition.

White sturgeon is a surrogate for the pallid sturgeon. The white sturgeon was tested for acute toxicity using Cadmium. The white sturgeon's SMAV showed that this species was more than 18 times higher than the 1.8 *ug*/L CMC at the 1-hour duration for dissolved Cadmium at 100 mg/L hardness. Fish were the most sensitive species tested making up eight of the first ten most sensitive species SMAV data results. The most sensitive fish species, bull trout, has a SMAV of more than twice the CMC at the 1-hour duration for dissolved Cadmium at 100 mg/L hardness. So, the Cadmium CMC criteria will be protective of the pallid sturgeon and may have insignificant effects that should never reach the scale where take occurs or in discountable effects that would be extremely unlikely to occur.

Based on the direct and indirect analysis, the use of the Cadmium acute criteria proposed by the Commonwealth of Kentucky **MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT** the federally listed Pallid sturgeon.

Palezone shiner and blackside dace (Family Cyprinidae)

The common carp, red shiner, zebrafish, fathead minnow, bonytail, and Colorado pikeminnow are surrogates considered for the five-listed species above as they are all in the same family *Cyprinidae*. The surrogates ranged in SMAVs from Colorado pikeminnow (46.79 *ug*/L) to common carp (30,781 *ug*/L) for total Cadmium at a hardness of 100 mg/L $CaCO_3$. These acute values were 26 to 17,100 times higher than the 1.8 *ug*/L CMC at the 1-hour duration for dissolved Cadmium at 100 mg/L hardness. The red shiner was tested for acute toxicity using Cadmium. The SMAV of 7,716 ug/L of Cd, was nearly 4,300 times higher than the 1.8 *ug*/L CMC at the 1-hour duration for dissolved Cadmium at 100 mg/L hardness.

Additionally, these species are primarily invertivores with diets including larval aquatic species and ingesting some detritus. As discussed in the Pallid sturgeon section above, the Cadmium CMC criteria will have no effect on the aquatic insect abundance or composition.

Based on this information, the Cadmium CMC criteria will have **NO EFFECT** on the *Cyprinidae* species that are federally listed palezone shiner and blackside dace, and **NO ADVERSE MODICATION** to their critical habitat.

Kentucky Arrow darter, relict darter, duskytail darter, and Cumberland darter

The diets for these four federally listed fish species are primarily invertivores eating larval aquatic species and some snails. As discussed above in the Snail and Pallid sturgeon sections, the Cadmium CMC criteria will have no effect on the snails or aquatic insect abundance or composition.

The surrogates for these species are the families *Salmoniformes* (trout and salmon), *Scorpaeniformes* (sculpin), and *Perciformes* (other bony fishes). These are the most sensitive in the Order *Actinopterygii* (bony fishes) which all these listed fish species share. The five most sensitive SMAV fish species are the bull trout (4.19 *ug*/L Cd), shorthead sculpin (4.40 *ug*/L Cd), mottled sculpin (4.418 *ug*/L Cd), brown trout (5.64 *ug*/L), and striped bass (5.64 *ug*/L). These SMAVs ranged from 2.4 to 3.1 times higher than the 1.8 *ug*/L CMC at the 1-hour duration for Cadmium at 100 mg/L hardness. The Cadmium CMC criteria may have insignificant effects that should never reach the scale where take may occur or only result in discountable effects as this would be extremely unlikely to occur.

Therefore, the of the Cadmium acute criteria proposed by the Commonwealth of Kentucky **MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT** these four federally listed fish species, and there will be **NO ADVERSE MODICATION** to their critical habitat.

BATS

Aquatic Insect Bat Food Items

Cadmium Insect Data Taken from Table 7 (Pages 37 - 42) of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs.			
Rank	GMAV *(ug/L total)*	Type, Scientific name	SMAV (*ug/L total*)
45	>1,637	Caddisfly, *Arctopsyche sp.*	>1,637
53	4,467	Mayfly, *Ephemerella subvaria*	4,467
63	7,798	Mayfly, *Hexagenia rigida*	7,798
70	>20,132	Little green stonefly, *Sweltsa sp.*	>20,132
71	22,138	Mayfly, *Rhithrogena hageni*	22,138
75	49,052	Midge, *Chironomus plumosus*	15,798
		Midge, *Chironomus riparius*	>152,301

Virginia big-eared bat, gray bat, Northern long-eared bat, and Indiana bat

These federally listed species of bats will be protected by the proposed CMC of 1.8 *ug*/L of Cd at a hardness of 100 mg/L $CaCo_3$, as it protects their flying food items that have an aquatic larval stage. The Cadmium criteria will protect the abundance and composition of aquatic invertebrates that emerge as flying food items. The most sensitive insect species tested was the Caddisfly with a SMAV that is more than 900 times higher than the CMC at the 1-hour duration for dissolved Cadmium at 100 mg/L hardness.

As the analysis above shows, the Cadmium CMC criteria on the federally listed bat species will have **NO EFFECT** based on protection of its flying insect food sources that emerge from an aquatic habitat.

BIRD

Least tern

The least tern eats mainly small fishes (generally less than 9 cm long), sometimes crustaceans or insects, obtained by diving from air into shallow water usually less than 4 m deep. Interior populations depend almost entirely on cyprinids. Based on the insects as food above for the federally listed bats, there will be no effect on the abundance or composition of aquatic invertebrates that emerge as flying food items. Based on the fish analysis above for the Laurel dace, blue shiner, spotfin chub, palezone shiner, and blackside dace (Family Cyprinidae), there will be no effect on the abundance or composition of these small fishes resulting from the proposed criteria for CMC Cadmium. Based on the fish analysis above for other small fishes (bluemask darter, slackwater darter, duskytail darter, Cumberland darter, boulder darter, Barrens topminnow, amber darter, goldline darter, Conasauga logperch, and snail darter), the Cadmium CMC criteria will not have any adverse effects on small fish abundance and/or composition.

Therefore, the proposed CMC Cadmium criteria will have **NO EFFECT** on the least tern based on protection of its fish food source.

A. 2.b. Cadmium Chronic (CCC) values by category: Clams/Mussels, Crustaceans/Crayfish, Fish, Bats and Birds

EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium Table 9 (Pages 49 – 50). Ranked Freshwater GMCVs. Note: All data adjusted to a total hardness of 100 mg/L as CaCO3 and expressed as total cadmium.			
Rank	GMCV *ug*/L total	Species by Common Name, Scientific Name	SMCV *ug*/L total
20	>38.66	Blue tilapia, *Oreochromis aureus*	>38.66c
19	36.7	Oligochaete, *Aeolosoma headleyi*	36.7
18	16.43	Bluegill, *Lepomis macrochirus*	16.43
17	15.16	Oligochaete, *Lumbriculus variegatus*	15.16
16	14.22	Smallmouth bass, *Micropterus dolomieu*	14.22c
15	14.17	Northern pike, *Esox lucius*	14.17c
14	14.16	Fathead minnow, *Pimephales promelas*	14.16
13	13.66	White sucker, *Catostomus commersonii*	13.66c
12	11.29	Fatmucket, *Lampsilis siliquoidea*	11.29
11	9.887	Pond snail, *Lymnaea stagnalis*	9.887
10	8.723	Flagfish, *Jordanella floridae*	8.723
9	3.516	Snail, *Aplexa hypnorum*	3.516
8	3.36	Atlantic salmon, *Salmo salar* (LS)	2.389
		Brown trout, *Salmo trutta*	4.725
7	3.251	Rio Grande cutthroat trout, *Oncorhynchus clarkii virginalis*	3.543
		Rainbow trout, *Oncorhynchus mykiss* (LS)	2.192
		Chinook salmon, *Oncorhynchus tshawytscha* (LS)	4.426
6	2.356	Brook trout, *Salvelinus fontinalis*	2.356
5	2.024	Cladoceran, *Daphnia magna*	0.915
		Cladoceran, *Daphnia pulex*	4.478
4	2	Midge, *Chironomus dilutus*	2
3	1.47	Mottled sculpin, *Cottus bairdii*	1.47
2	1.293	Cladoceran, *Ceriodaphnia dubia*	1.293
1	0.7453	Amphipod, *Hyalella azteca*	0.7453

All the values have been normalized to a hardness of 100 mg/L of $CaCO_3$ and represent the total Cadmium. These values show the Genus Mean Chronic Value (GMCV) and the Species Mean Chronic Value (SMCV). The Final Chronic Value (FCV) of 0.72 *ug*/l for Cadmium is with water at a hardness of 100 *ug*/L $CaCO_3$. This FCV was developed by using the four most sensitive GMCV.

CLAMS/MUSSELS

The Federally listed 20 Unionid mussels and the 1 Margaritiferidae mussel

The fat mucket *Unionidae* mussel is the surrogate for the 20 Federally listed Unionid mussels and one Margaritiferidae mussel shown in Table III.A. The fat mucket was the 12th most sensitive species tested for chronic effects with a SMCV of 11.29 *ug*/L total Cadmium. Amphipods, Cladoceran, trout, salmon, snails and flagfish were all more sensitive than the fatmucket (*Lampsilis* siliquidoidea) mussel. This

mussel's SMCV is 15.7 times higher than the FCV of 0.72 *ug*/L total Cadmium. Snails share the same phylum, *Mollusca*, as these federally listed mussels. The most sensitive snail tested was the *Aplexa hypnorum* snail. This species SMCV was 3.5 *ug*/L total Cd or 4.9 times higher than the CCC of 0.72 *ug*/L total Cadmium. The Cadmium CCC criteria will be protective of *Unionidae* and *Margaritiferidae* mussels and may have insignificant effects that should never reach the scale where take may occur or have discountable effect that would be extremely unlikely to occur.

The proposed CCC criterion for Cadmium is not likely to adversely affect fish species, including sculpin which have been found to be glochidial hosts for some Unionoid species. The endangered fanshell, dromedary pearlymussel, Cumberlandian combshell, snuffbox mussel, littlewing pearlymussel, fluted kidneyshell, and Cumberland bean have all been determined to use sculpin as glochidial hosts.

Therefore, the CCC criteria for Cadmium **MAY EFFECT, NOT LIKELY TO ADVERSELY AFFECT** the 20 Federally listed Unionid mussels and the one *Margaritiferidae* mussel in Table III.A., and there will be **NO ADVERSE MODICATION** to their critical habitat.

CRUSTACEANS/CRAYFISH

Big Sandy Cray Fish and the Kentucky Cave Shrimp

Invertebrates make up three of the four GMCVs used to calculate the Cadmium FCV of 0.72 *ug*/L. These three invertebrates are an amphipod, cladoceran, and a midge (Chironomid). The amphipod and cladoceran are in the same phylum *Crustacea* as the listed species. The amphipod, *Hyalella Azteca*, and the Big Sandy cray fish are in same Order "Malacostraca". Amphipods (GMCV = 0.74 *ug*/L total Cd) and Cladoceran (GMCV = 1.29 *ug*/L total Cd) are considered as surrogates for the crayfish because there were no chronic tests for either genus or family.

The relationship in Cadmium sensitivity between the amphipods and cladocerans in the acute test results was reviewed. Crayfish ranked 22 of the 75 most sensitive Cadmium GMAVs, the amphipod's GMAV ranked 7th (23 *ug*/L total Cd) and the cladoceran's GMAVs ranked 12th, 17th, 18th, 23rd, 24th and 25th (61.4, 73.7, 74.3, 99.5, 103.1, and 120.1 *ug*/L total Cd) (Table 7 [Pages 37 – 42] of EPA's 2016 Aquatic Life Ambient Water Quality Criteria Cadmium. Ranked Freshwater GMAVs). The crayfish's Cadmium GMAV was 94.7 *ug*/L, which was right in the middle of the cladoceran's range. So, the cladoceran were considered more representative of Cadmium sensitivity to the crayfish than were the amphipods. The Cadmium CCC criteria will be protective of the listed species and result with insignificant effects that should never reach the scale where take occurs or is a discountable effect that would be extremely unlikely to occur.

Therefore, the Cadmium CCC criteria **MAY EFFECT, NOT LIKELY TO ADVERSELY AFFECT** the Big Sandy crayfish and the Kentucky Cave Shrimp.

FISHES

Pallid sturgeon, palezone shiner, blackside dace, Kentucky arrow darter, relict darter, duskytail darter, and Cumberland darter

Invertebrates (amphipod, cladoceran and midges) and fishes (sculpin, trout and salmon) represent the most sensitive species tested for Cadmium chronic effects. The sculpin, trout, and salmon are surrogates for all 7 federally listed fish species. The mottled sculpin (*Cottus bairdii*) was the most sensitive fish of the 14 fish species test results found in the most sensitive 24 SMCVs. The mottled sculpin was the most

sensitive fish species tested and ranked 3rd with a SMCV of 1.47 *ug*/L of Cadmium at a hardness of 100 mg/L $CaCO_3$. This fish's SMCV was 2 times higher than the FCV of 0.72 *ug*/L Cadmium. The brook trout was the second most sensitive fish species tested for Cadmium chronic effects and it was the 6th most sensitive species tested for Cadmium chronic effects. The brook trout's SMCV was 2.35 *ug*/L Cadmium or 3.3 times higher than the 0.72 *ug*/L Cadmium. The Atlantic salmon had the third most sensitive chronic effects to Cadmium with a SMCV of 2.4 *ug*/L or 3.7 times higher than the FCV of 0.72 *ug*/L. The Cadmium CCC criteria will be protective of all fish species and may have insignificant effects that should never reach the scale where take may occur or have discountable effects that would be extremely unlikely to occur.

These 7 federally listed endangered species fish are primarily invertivores. The invertebrates comsumed are mainly insects with some snail, mussel, crustacean and fish food items. As discussed in the Snail, Mussel, Crayfish and Fish categories above, the Cadmium CCC criteria will be protective of these food items. There should be no change in these food item's abundance or composition.

In conclusion, the Cadmium CCC criteria **MAY AFFECT, NOT LIKELY ADVERSELY AFFECT** the 7 federally listed and one proposed listed fish species or their critical habitat, and there will be **NO ADVERSE MODICATION** to their critical habitat.

BATS

Virginia big-eared bat, gray bat, Northern long-eared bat, and Indiana bat

These federally listed species may eat flying insects that have an aquatic life stage. So, the impact of the proposed Cadmium CCC criteria was evaluated to see if there may be effects on these emerging insects in their larval, aquatic form.

The midge, *Chironomus dilutus*, is a Diptera insect with an aquatic larval stage that looks like a small worm. This species has a SMCV of 2.0 *ug*/L. This is 2.8 times higher than the FCV of 0.72 *ug*/L Cadmium. There will not be any change in the aquatic life stages of insect abundance and/or composition.

Therefore, the Cadmium CCC criteria will have **NO EFFECT** on the Virginia big-eared bat, gray bat, Northern long-eared bat, and Indiana bat through the protection of their food sources.

BIRD

Least tern

The least tern eats mainly small fishes (generally less than 9 cm long), sometimes crustaceans or insects, obtained by diving from air into shallow water usually less than 4 m deep. Interior populations depend almost entirely on cyprinids. Based on the insects as food above for the federally listed bats, there will be no effect on the abundance or composition of aquatic invertebrates that may be food items for the least tern from the proposed Cadmium CCC criteria.

Based on the fish analysis above, for the 7 federally listed fish species, there will be no effect on the abundance or composition of small fishes that may be food items for the least tern resulting from the proposed criteria for CCC Cadmium. The Cadmium CCC criteria will have no effect on small fish abundance and/or composition.

Based on this information, the Cadmium CCC criteria will have **NO EFFECT** on the least tern through the protection of its insect and/or fish food sources.

Chapter IV.

B. Manner in which EPA's Approval of Carbaryl CMC & CCC may affect the Federally Listed Species and their critical habitat

B. 1. Adopted values of Carbaryl –

Kentucky has adopted the EPA's April 2012, Aquatic Life Ambient Water Quality Criteria Recommendations for Carabaryl.

	CMC µg/L	CCC µg/L
Carbaryl	2.1	2.1

The final acute criteria (Criterion Maximum Concentration – CMC) applies when the one-hour average concentration for carbaryl does not exceed 2.1 *ug*/L.

The final chronic criteria (Criterion Continuous Concentration – CCC) for carbaryl is 2.1 *ug*/L and that allows for no unacceptable adverse effects if the four-day average concentration of carbaryl does not exceed 2.1 *ug*/L.

EPA's Aquatic Life Ambient Water Quality Criteria for Carbaryl (CAS Registry Number 63-25-2), April 2012 USEPA, OW, OS&T, Health & Ecological Criteria Division, Washington, D.C. 189 pages. https://www.epa.gov/sites/production/files/2015-08/documents/aquatic_life_ambient_water_quality_criteria_for_carbaryl_-_2012.pdf , as viewed between February 7 and 10, 2019. This document is referenced as EPA Carbaryl 2012 in this biological evaluation.

NOTE: We did an ECOTOX review on December 4, 2018, for carbaryl and the newest reports were 2017. We reviewed the documents from 2012 through 2017 as these references would not have been considered for use in the development of the Ambient Aquatic Life Water Quality Criterial for Carbaryl. There were no new references that were usable from this ECOTOX review (Appendix A).

B. 2. Carbaryl Acute and Chronic Aquatic Life Criteria of 2.1 *ug*/L effect on Clams/Mussels, Crustaceans/Crayfish, Fish, Bats and Birds

Table IV.B.1.
Modified Table 4 Ranked Freshwater Genus Mean Acute Values EPA Carbaryl 2012, pgs 21-23

Rank	Common Name	Scientific Name	SMAC (*ug*/L)	GMAV (*ug*/L)
47	Walking catfish	*Clarias batrachus*	27,609	27,609
46	Snail	*Aplexa hypnorum*	>27,000	>27,000
45	Mussel	*Anodonta imbecillis*	24,632	24,632
44	Black bullhead	*Ameiurus melas*	20,000	20,000
43	Goldfish	*Carassius auratus*	16,700	16,700
42	Green frog	*Rana clamitans*	16,296	16,296
41	Channel catfish	*Ictalurus punctatus*	12,400	12,400
40	Boreal toad	*Bufo boreas*	12,310	12,310

Table IV.B.1.
Modified Table 4 Ranked Freshwater Genus Mean Acute Values EPA Carbaryl 2012, pgs 21-23

Rank	Common Name	Scientific Name	SMAC (*ug*/L)	GMAV (*ug*/L)
39	Green sunfish	*Lepomis cyanellus*	9,460	9,039
	Redear sunfish	*L. microlophus*	11,200	-
	Bluegill	*L. macrochirus*	6,970	-
38	European chub	*Leuciscus cephalus*	8,656	8,656
37	Oligochaete worm	*Lumbriculus variegatus*	8,200	8,200
36	Fathead minnow	*Pimephales promelas*	8,012	8,012
35	Largemouth bass	*Micropterus salmoides*	6,400	6,400
34	Razorback sucker	*Xyrauchen texanus*	4,350	4,350
33	Common carp	*Cyprinus carpio*	4,153	4,153
32	Gila topminnow	*Poeciliopsis occidentalis*	>3,000	>3,000
31	Nile tilapia	*Oreochromis niloticus*	2,930	2,930
30	Bonytail chub	*Gila elegans*	2,655	2,655
29	Black crappie	*Pomoxis nigromaculatus*	2,600	2,600
28	Guppy	*Poecilia reticulata*	2,515	2,515
27	Yellow perch	*Perca flavescens*	2,480	2,480
26	Gray tree frog	*Hyla versicolor*	2,470	2,470
25	Crayfish	*Faxonius immunis*	2,870	2,462
	Crayfish	*F. virilis*	2,112	-
24	Greenthroat darter	*Etheostoma lepidum*	2,140	2,079
	Fountain darter	*E. fonticola*	2,020	-
23	Colorado pikeminnow	*Ptychocheilus lucius*	2,005	2,005
22	Apache trout	*Oncorhynchus apache*	1,540	1,810
	Coho salmon	*O. kisutch*	1,654	-
	Chinook salmon	*O. tshawytscha*	2,690	-
	Cutthroat trout	*O. clarkii*	3,300	-
	Rainbow trout	*O. mykiss*	860	-
21	Shortnosed sturgeon	*Acipenser brevirostrum*	1,810	1,810
20	African clawed frog	*Xenopus laevis*	1,730	1,730
19	Striped bass	*Morone saxatilis*	1,322	1,322
18	Brook trout	*Salvelinus fontinalis*	1,629	1,269
	Lake trout	*S. namaycush*	988.1	-
17	Crayfish	*Procambarus clarkii*	1,000	1,000
16	Atlantic salmon	*Salmo salar*	1,129	889
	Brown trout	*S. trutta*	700	-
15	Crayfish	*Cambarus bartoni*	839.6	839.6
14	Aquatic sowbug	*Asellus brevicaudus*	280	280
13	Amphipod	*Pontoporeia hoyi*	250	250
12	Mysid	*Mysis relicta*	230	230
11	Backswimmer	*Notonecta undulata*	200	200

Table IV.B.1. Modified Table 4 Ranked Freshwater Genus Mean Acute Values EPA Carbaryl 2012, pgs 21-23				
Rank	**Common Name**	**Scientific Name**	**SMAC (*ug*/L)**	**GMAV (*ug*/L)**
10	Amphipod	*Hyalella azteca*	15.2	15.2
9	Amphipod	*Gammarus lacustris*	18.76	13.78
	Amphipod	*G. pseudolimnaeus*	10.12	-
8	Cladoceran	*Daphnia carinata*	35	11.9
	Cladoceran	*D. magna*	7.521	-
	Cladoceran	*D. pulex*	6.4	-
7	Stonefly	*Pteronarcella badia*	9.163	9.163
6	Cladoceran	*Simocephalus serrulatus*	8.781	8.781
5	Cladoceran	*Ceriodaphnia dubia*	5.958	5.958
4	Stonefly	*Claassenia sabulosa*	5.6	5.6
3	Stonefly	*Pteronarcys californica*	4.8	4.8
2	Stonefly	*Skwala sp.*	3.6	3.6
1	Stonefly	*Isogenus sp.*	3.175	3.175

CLAMS/MUSSELS

21 mussels are listed as endangered and threatened (See Table III.A.)

Table IV. B. 2. Mullusk Data from Table IV. B. 1.			
Common Name	**Scientific Name**	**SMAC (*ug*/L)**	**GMAV (*ug*/L)**
Snail	*Aplexa hypnorum*	>27,000	>27,000
Mussel	*Anodonta imbecillis*	24,632	24,632

The surrogates for the federally listed threatened and endangered mussels were the freshwater mussel (paper pondshell) *Anodonta imbecillis* and tan aquatic snail, *Aplexa hypnorum*. The federally listed freshwater mussels share the same Family *Unionidae* with the paper pondshell mussel while the aquatic snail shares the same taxonomic Phylum, *Mollusca*. This phylum was the least sensitive of all the phylum tested with the two genus represented being 45th and 46th out of 47 genus tested (See Table A for ranking). Based on this data, mussels are very tolerant to carbaryl. These data are more than 11,700 times higher than the proposed 2.1 *ug*/L proposed carbaryl CMC and CCC criteria.

Table IV.B.3. Fish Data from Table IV.B.1.			
Common Name	**Scientific Name**	**SMAC (*ug*/L)**	**GMAV (*ug*/L)**
Walking catfish	*Clarias batrachus*	27,609	27,609
Black bullhead	*Ameiurus melas*	20,000	20,000
Goldfish	*Carassius auratus*	16,700	16,700
Channel catfish	*Ictalurus punctatus*	12,400	12,400
Green sunfish	*Lepomis cyanellus*	9,460	9,039
Redear sunfish	*L. microlophus*	11,200	-

Table IV.B.3. Fish Data from Table IV.B.1.			
Common Name	**Scientific Name**	**SMAC (*ug*/L)**	**GMAV (*ug*/L)**
Bluegill	*L. macrochirus*	6,970	-
European chub	*Leuciscus cephalus*	8,656	8,656
Fathead minnow	*Pimephales promelas*	8,012	8,012
Largemouth bass	*Micropterus salmoides*	6,400	6,400
Razorback sucker	*Xyrauchen texanus*	4,350	4,350
Common carp	*Cyprinus carpio*	4,153	4,153
Gila topminnow	*Poeciliopsis occidentalis*	>3,000	>3,000
Nile tilapia	*Oreochromis niloticus*	2,930	2,930
Bonytail chub	*Gila elegans*	2,655	2,655
Black crappie	*Pomoxis nigromaculatus*	2,600	2,600
Guppy	*Poecilia reticulata*	2,515	2,515
Yellow perch	*Perca flavescens*	2,480	2,480
Greenthroat darter	*Etheostoma lepidum*	2,140	2,079
Fountain darter	*E. fonticola*	2,020	-
Colorado pikeminnow	*Ptychocheilus lucius*	2,005	2,005
Apache trout	*Oncorhynchus apache*	1,540	1,810
Coho salmon	*O. kisutch*	1,654	-
Chinook salmon	*O. tshawytscha*	2,690	-
Cutthroat trout	*O. clarkii*	3,300	-
Rainbow trout	*O. mykiss*	860	-
Shortnosed sturgeon	*Acipenser brevirostrum*	1,810	1,810
Striped bass	*Morone saxatilis*	1,322	1,322
Brook trout	*Salvelinus fontinalis*	1,629	1,269
Lake trout	*S. namaycush*	988.1	-
Atlantic salmon	*Salmo salar*	1,129	889
Brown trout	*S. trutta*	700	-

The federally listed mussels have a parasite life stage that uses various fish species as hosts. Data were collected from 23 genus and 32 species of fish from tests with carbaryl. These data ranged from 333 to over 13,000 times higher than the proposed 2.1 *ug*/L acute and chronic carbaryl criteria. Based on these data, the carbaryl criteria will not change the abundance or composition of fish in Kentucky waters.

Therefore, the proposed CMC and CCC criteria for Carbaryl will have **NO EFFECT** on the federally listed mussel species.

CRUSTACEANS/CRAYFISH

Big Sandy Cray Fish and Kentucky Cave Shrimp

Table IV.B.4. Crayfish Data from Table IV.B.1.			
Common Name	**Scientific Name**	**SMAC (*ug*/L)**	**GMAV (*ug*/L)**

Crayfish	*Faxonius immunis*	2,870	2,462
Crayfish	*F. virilis*	2,112	-
Crayfish	*Procambarus clarkii*	1,000	1,000
Crayfish	*Cambarus bartoni*	839.6	839.6

Four species of crayfish were used as the surrogates for the federally endangered species. All four of these species share the same Family, *Cambaridae*, as the Big Sandy Cray Fish and the same Order, *Decapodia*, for both endangered species. These data were 400 to 1,400 times higher than the proposed CMC and CCC carbaryl aquatic life criteria of 2.1*ug*/L.

Based on this data, the proposed acute and chronic criteria for Carbaryl will have **NO EFFECT** on the Big Sandy Cray Fish and Kentucky Cave Shrimp.

FISH

Pallid sturgeon, palezone shiner, blackside dace, Kentucky arrow darter, relict darter, duskytail darter, and Cumberland darter

The 7 endangered and threatened fish represent four Genus (*Etheostoma, Notropis, Phoxinus,* and *Scaphirhynchus*), three Families (*Cyprinidae, Percidae,* and *Acipenseridae*), three Orders (*Cypriniformes, Perciformes,* and *Acipenseriformes*) and one Class (*Actinopterygii*) Table III.D.

Table IV.B.5.
Fish Data taken from Table IV.B.1. by Common Name, Scientific Name, SMAC, GMAV, Class, Order and Family

Common Name	Scientific Name	SMAC (*ug*/L)	GMAV (*ug*/L)	Class	Order	Family
Walking catfish	*Clarias batrachus*	27,609	27,609	Actinopterygii	Siluriformes	Clariidae
Black bullhead	*Ameiurus melas*	20,000	20,000	Actinopterygii	Siluriformes	Ictaluridae
Goldfish	*Carassius auratus*	16,700	16,700	Actinopterygii	Cypriniformes	Cyprinidae
Channel catfish	*Ictalurus punctatus*	12,400	12,400	Actinopterygii	Siluriformes	Ictaluridae
Green sunfish	*Lepomis cyanellus*	9,460	9,039	Actinopterygii	Perciformes	Centrarchidae
Redear sunfish	*L. microlophus*	11,200	-	Actinopterygii	Perciformes	Centrarchidae
Bluegill	*L. macrochirus*	6,970	-	Actinopterygii	Perciformes	Centrarchidae
European chub	*Leuciscus cephalus*	8,656	8,656	Actinopterygii	Cypriniformes	Cyprinidae
Fathead minnow	*Pimephales promelas*	8,012	8,012	Actinopterygii	Cypriniformes	Cyprinidae
Largemouth bass	*Micropterus salmoides*	6,400	6,400	Actinopterygii	Perciformes	Centrarchidae
Razorback sucker	*Xyrauchen texanus*	4,350	4,350	Actinopterygii	Cypriniformes	Catostomidae

Table IV.B.5.
Fish Data taken from Table IV.B.1. by Common Name, Scientific Name, SMAC, GMAV, Class, Order and Family

Common Name	Scientific Name	SMAC (*ug*/L)	GMAV (*ug*/L)	Class	Order	Family
Common carp	*Cyprinus carpio*	4,153	4,153	Actinopterygii	Cypriniformes	Cyprinidae
Gila topminnow	*Poeciliopsis occidentalis*	>3,000	>3,000	Actinopterygii	Cyprinodontiformes	Poeciliidae
Nile tilapia	*Oreochromis niloticus*	2,930	2,930	Actinopterygii	Perciformes	Cichlidae
Bonytail chub	*Gila elegans*	2,655	2,655	Actinopterygii	Cypriniformes	Cyprinidae
Black crappie	*Pomoxis nigromaculatus*	2,600	2,600	Actinopterygii	Perciformes	Centrarchidae
Guppy	*Poecilia reticulata*	2,515	2,515	Actinopterygii	Cyprinodontiformes	Poeciliidae
Yellow perch	*Perca flavescens*	2,480	2,480	Actinopterygii	Perciformes	Percidae
Greenthroat darter	*Etheostoma lepidum*	2,140	2,079	Actinopterygii	Perciformes	Percidae
Fountain darter	*E. fonticola*	2,020	-	Actinopterygii	Perciformes	Percidae
Colorado pikeminnow	*Ptychocheilus lucius*	2,005	2,005	Actinopterygii	Cypriniformes	Cyprinidae
Apache trout	*Oncorhynchus apache*	1,540	1,810	Actinopterygii	Salmoniformes	Salmonidae
Coho salmon	*O. kisutch*	1,654	-	Actinopterygii	Salmoniformes	Salmonidae
Chinook salmon	*O. tshawytscha*	2,690	-	Actinopterygii	Salmoniformes	Salmonidae
Cutthroat trout	*O. clarkii*	3,300	-	Actinopterygii	Salmoniformes	Salmonidae
Rainbow trout	*O. mykiss*	860	-	Actinopterygii	Salmoniformes	Salmonidae
Shortnosed sturgeon	*Acipenser brevirostrum*	1,810	1,810	Actinopterygii	Acipenseriformes	Acipenseridae
Striped bass	*Morone saxatilis*	1,322	1,322	Actinopterygii	Perciformes	Moronidae
Brook trout	*Salvelinus fontinalis*	1,629	1,269	Actinopterygii	Salmoniformes	Salmonidae
Lake trout	*S. namaycush*	988.1	-	Actinopterygii	Salmoniformes	Salmonidae
Atlantic salmon	*Salmo salar*	1,129	889	Actinopterygii	Salmoniformes	Salmonidae
Brown trout	*S. trutta*	700	-	Actinopterygii	Salmoniformes	Salmonidae

Greenthroat darter (*Etheostoma lepidum)* and the fountain darter (*E. fonticola)* are the surrogates for the federally listed duskytail darter, Kentucky arrow darter, Cumberland darter, and Relict darter because they shared the same Genus *Etheostoma.* The darter GMAV of 2,079 *ug*/L is 990 higher than the proposed CMC and CCC for carbaryl of 2.1 *ug*/L.

Shortnosed sturgeon (*Acipenser brevirostrum)* is the surrogate for the federally listed pallid sturgeon because they share the same Genus *Acipenser.* The sturgeon GMAV of 1,810 *ug*/L is 862 times higher than the proposed CMC and CCC for carbaryl of 2.1 *ug*/L.

European chub (*Leuciscus cephalus)*, Fathead minnow (*Pimephales promelas)*, Common carp (*Cyprinus carpio)*, Bonytail chub (*Gila elegans)*, Colorado pikeminnow and (*Ptychocheilus lucius)* are the surrogates for the federally listed palezone shiner and blackside dace because they share the same Family *Cyprinidae.* The most sensitive surrogate species to carbaryl was the Colorado pikeminnow with a SMAC of 2,005 *ug*/L. This value is over 950 times higher than the proposed CMC and CCC for carbaryl of 2.1 *ug*/L.

These federally listed fish species are primarily invertivores. Their diet is primarily aquatic insects with some snails, mussels, crustaceans and fish. Insects are the most sensitive organisms used in the development of the carbaryl CMC and CCC. The Plecoptera (stoneflies) were the most sensitive insects followed by the Ceriodaphnia, Daphnia then amphipods. The seventeen most sensitive species are the isopods, amphipods, mysids, daphnia, Ceriodaphnids then the stoneflies. The stoneflies (*Plecoptera*) had five of the top ten most sensitive SMACs ranging from 3.1 *ug*/Lto 9.2 *ug*/L. The median value for the stonefly data was a SMAC of 4.8 *ug*/L. This was followed by the Cladocerans that had five of the ten sensitive SMACs ranging from 6.0 *ug*/Lto 35.0 *ug*/L. The median value for the Cladocerans was 6.4 *ug*/L. The amphipods came next in sensitivity with SMACs from 10.1 *ug*/Lto 18.8. The most sensitive of all of the data used to develop the CMC and CCC was a stonefly *Isogenus* sp. that has a SMAC of 3.2 *ug*/L. This is 1.5 times higher than the proposed CMC and CCC carbaryl aquatic life criteria. The proposed carbaryl criteria will result in the aquatic insect population's abundance or composition to remain unchanged. Additionally, there will be no change to the abundance or composition of the snail, mussel, crustacean and fish populations. This is based on the analysis above in the SNAILs, MUSSELS, CRUSTACEAN and FISH sections. So, there will be no change to the abundance or composition of the aquatic pray populations from the proposed Carbaryl CMC and CCC criteria.

In conclusion, the proposed CMC and CCC for Carbaryl of 2.1 *ug*/L will have **NO EFFECT** on the 7 federally listed fish species.

BATS

Virginia big-eared bat, gray bat, Northern long-eared bat, and Indiana bat

The proposed acute and chronic Carbaryl criteria is for the protection of aquatic life and not for terrestrial wildlife that may feed upon emerging aquatic macroinvertebrates with a flying adult insect.

Eidels, et al., (2013) found chlorpyrifos and carbaryl in bat samples and was surprised because they considered these two chemicals to be short-lived and do not persist in the living body[2]. They also sited other authors who suggested that since ChE inhibitors do not tend to bioaccumulate in living tissue, that their presence is indicative of recent exposure prior to death.

As discussed above in FISH section, there should be no adverse effects on the abundance and/or composition of aquatic invertebrates that have an aquatic larval stage. So, there should be no change to the abundance and/or composition of emerging flying insects that bats may feed upon.

Therefore, the proposed acute and chronic carbaryl criteria will have **NO EFFECT** on federally listed bat species.

BIRD

Least tern

The proposed acute carbaryl criteria is for the protection of aquatic life and not for terrestrial wildlife that may feed upon fish or aquatic invertebrates.

Mitra et al., (2011) states that organophosphates and carbamates do not bioaccumulate in the food chains and are less persistent and that they have replaced the more persistent organochlorines[3].

The endangered least tern (Sterna antillarum) eats mainly small fishes, generally less than 9 cm in lengths, with interior populations depending almost entirely on cyprinids. However, they may also eat aquatic insects. There will be not any effect from the proposed acute and chronic carbaryl criterion on the abundance and/or composition of the least tern's insect or fish food items (See above, FISH).

Therefore, the proposed acute and chronic carbaryl criteria will have **NO EFFECT** on the least tern.

[2] Eidels, R.R>, J.O. Whitaker, Jr., M.J. Lydy, and D.W. Sparks. 2013. Screening of Insecticides in Bats from Indiana. Proceedings of the Indiana Academy of Science 121(2):133-142, page 139

[3]Anindita Mitra, Chandranath Chatterjee and Fatik B. Mandal, 2011. Synthetic Chemical Pesticides and Their Effects on Birds. Research Journal of Environmental Toxicology, 5: 81-96.

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Chapter IV. Manner of Effect by Specific Action

C. Critical Habitat in Kentucky Waters

Federally listed aquatic and aquatic species that have designated Critical Habitat (CH) within the Commonwealth of Kentucky are listed in Chapter III - Table A. All these designated CHs are rivers, creeks, forks or branches are reaches of flowing water that are waters of the United States and waters of the Commonwealth of Kentucky, Chapter III - Table B.

Each CH is a geographical area occupied by the species at the time of listing that contains physical or biological features essential to the conservation of the species and may require special management considerations or protection and sometimes contains specific areas outside the geographical area occupied by the species, if it is determined that the area itself is essential for conservation (50 CFR §424.12(b)).

Critical habitat physical or biological features are those features that support the life-history needs of the species, including but not limited to water characteristics and prey (50 CFR §424.11 Definitions *Physical or biological features*).

The acute and chronic criteria evaluated for the two chemicals considered in this biological evaluation should be considered as essential constituents of the various CHs. These acute and chronic criteria are essential to the conservation of the species. These criteria identify protective concentrations that will prevent any direct adverse effect on the aquatic species and the aquatic life-stages of water dependent species. These criteria are also essential to the conservation of the species because they prevent an adverse indirect effect on the federally listed species through an adverse change in the composition and/or abundance of their aquatic or aquatic dependent prey species.

In conclusion, all the acute and chronic criteria considered within this biological evaluation will protect all the aquatic CH considered in this biological evaluation. **None of the criteria considered in this biological evaluation will destroy or adversely modify any of the aquatic CH considered in this biological evaluation**. Each of the aquatic CH considered in this biological evaluation has listed as part of their essential conservation physical or biological features the acute and chronic aquatic life criteria analyzed within this biological evaluation.

Chapter V. EPA Findings

The following summarizes EPA's findings of "No Effect" (NE) or may affect - 'Not Likely To Adversely Affect" (NLTAA) for each individual species and if pertinent, the findings of "No Adverse Modification" (NAM) for each species' Critical Habitat (CH) by proposed acute and chronic criteria for each of the two chemicals.

A. The following is a summarization of EPA's findings by Category (Mussels, Crayfish, Fish, Bats and Bird, See Table III.A.) for each proposed criterion.

Cadmium Acute Criterion
Mussels – NE, Mussel CH – NAM, Crayfish – NE, Fish NE & NLTAA,
Fish CH – NAM, Bats – NE and Bird – NE.

Cadmium Chronic Criterion
Mussels - NLTAA, Mussel CH – NAM, Crayfish – NLTAA, Fish NLTAA, Fish – NJ, Fish CH – NAM, Bats – NE and Bird – NE.

Carbaryl Acute Criterion
Mussels – NE, Mussel CH – NAM, Crayfish – NE, Fish - NE, Fish – NJ, Fish CH – NAM, Bats – NE and Bird NE

Carbaryl Chronic Criterion
Mussels – NE, Mussel CH – NAM, Crayfish – NE, Fish - NE, Fish – NJ, Fish CH – NAM, Bats – NE and Bird NE

B. Findings of No Effect by proposed criterion and category (Mussels, Crayfish, Fish, Bats and Bird, see Table III.A) and no written concurrence is required with FWS.

No Effects for:

Cadmium Acute Criterion
Mussels – NE, Crayfish – NE, Fish NE Cyprinidae, Bats – NE, Bird - NE

Cadmium Chronic Criterion
Bats – NE and Bird - NE

Carbaryl Acute Criterion
Mussels – NE, Crayfish – NE, Fish - NE, Bats – NE and Bird - NE

Carbaryl Chronic Criterion
Mussels – NE, Crayfish – NE, Fish - NE, Bats – NE and Bird - NE

C. May Affect – Not Likely to Adversely Affect by Criterion and Category, and requires Written Concurrence with FWS

Cadmium Acute Criterion
Fish NLTAA - pallid sturgeon, Kentucky arrow darter, duskytail darter, and Cumberland darter

Cadmium Chronic Criterion
Mussels - NLTAA, Crayfish – NLTAA, Fish NLTAA – all 20 listed fish

Carbaryl Acute Criterion
None

Carbaryl Chronic Criterion
None

D. Mussel and Fish Critical Habitat Findings of No Adverse Modification by Criterion requires concurrence with the FWS

Cadmium Acute Criterion, Cadmium Chronic Criterion, Carbaryl Acute Criterion, and Carbaryl Chronic Criterion

APPENDIX A

401 KAR 10:031
Surface Water Standards
Redline Version